

SECTION 400513

PIPING

PART 1 – GENERAL

101. GENERAL

- 101.1 The piping systems and appurtenances provided by the CONTRACTOR shall conform to the requirements of the governing Code(s); in other respects, piping shall conform to the requirements of this Section and shall satisfy all conditions and requirements of the specification.
- 101.2 In the event of variance between the general requirements delineated in this Section and the particular requirements set forth in the specification, the specification shall take precedence.
- 101.3 For systems designed by the CONTRACTOR, the requirements of this Section and the specification shall be used to determine the appropriate valve.
- 101.4 Definitions
- a. The term “piping” used in this specification includes straight pipe, pipe bends, tees, reducers, sockets, flanges, bolts, gaskets and other fittings.
 - b. Large Bore Piping – piping or tubing 2½ inches and larger
 - c. Small Bore Piping – piping or tubing 2 inches and smaller
- 101.5 Scope
- a. CONTRACTOR shall design, furnish, and install all piping, fittings, thermocouple wells, appurtenances and all of the accessories required to fully complete the erection and including all work for or incidental to the operation of the plant as defined in the specification.
 - b. CONTRACTOR shall furnish all necessary welding rod including that required for training welders.
- 101.6 Referenced Documents
- a. Publications of the following agencies shall form a part of the specification to the extent specified therein. All references to their publications are to the latest issue of each, together with the latest additions and/or amendments thereto, as of the date of Contract, unless otherwise indicated. References to the sponsoring agencies will be made in accordance with the abbreviations indicated:
 - a1. ANSI American National Standards Institute, Inc.
 - a2. ASME American Society of Mechanical Engineers
 - a3. ASTM ASTM International
 - a4. AWS American Welding Society
 - a5. AWWA American Water Works Association
 - a6. ISO International Organization for Standardization
 - a7. MSS Manufacturers Standardization Society of the Valve and Fitting Industry
 - a8. NFPA National Fire Protection Association
 - a9. PFI Pipe Fabricator's Institute Standard
 - b. Other codes and standards including those of other countries can only be used with the formal acceptance of the DISTRICT.



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Specification G-5301
Issue: Client Comments, Rev. 2
December 31, 2009
Project No. 12194-004

102. CODES

- 102.1 The design, materials, fabrication, construction, testing and certification of all pipe, valves pressure vessels, components and component supports shall conform to the following Codes, as applicable and as specified in this section and to all federal, state and local codes and regulations having jurisdiction:
- a. ANSI/ASME B31.1 – Power Piping Code (Non-boiler External Piping; also applies to the materials, design, fabrication, installation and testing of Boiler External Piping under the jurisdiction of ASME Section I).
 - b. ASME B36.10 – Welded and Seamless Wrought Steel Pipe
 - c. ASME B36.19 – Stainless Steel Pipe
 - d. PFI ES-4 – Hydrostatic Testing of Fabricated Piping
 - e. PFI ES-5 – Cleaning of Fabricated Piping
 - f. PFI ES-31 – Standard for Protection of Ends of Fabricated Piping Assemblies
 - g. SSPC – Standard Steel Structures Painting Council
- 102.2 Certification and Data Reports for all piping, vessels and components furnished by CONTRACTOR shall be submitted in accordance with the requirements of the applicable section of the above codes and (where applicable) standards specified.

PART 2 – PRODUCTS

201. TECHNICAL REQUIREMENTS

201.1 General

- a. CONTRACTOR shall conform to all requirements of ASME B31.1 Power Piping Code for the design and fabrication of pipe.
- b. Provision shall be made in pump suction piping for temporary and permanent strainers.

201.2 Piping System Design

- a. Unless otherwise specified, all vents and drains up to and including the last valve from piping or equipment shall be of the same material and pressure standard as specified for the corresponding piping in the system to which the drains are connected. The last valve in a vent or drain line may be subject to the full system pressure on its inlet side and atmospheric (or near atmospheric) on the outlet side.
- a1. Pipe shall be provided with low point drains and high point vents as required for startup and normal operation.
- a2. Piping shall be properly sloped, in order to meet the drain and discharge requirements under cold and hot conditions.
- b. Where the pipe wall thickness or schedule specified is not readily available, substitution of heavier (or lighter) wall pipe will not be permitted unless written permission is obtained from the DISTRICT.
- c. Where the type, class, grade or quality of material specified is not available, CONTRACTOR must obtain permission from the DISTRICT before a substitute type, class, grade or quality of material can be used.
- d. CONTRACTOR shall design piping terminal point connections in accordance with equipment manufacturer allowable nozzle loading recommendations or Table 2-1 when equipment nozzle loads are not available. Small bore piping 2" and less shall have a terminal anchor with acceptable lateral movement (zero movement is preferred).



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201.3 Miscellaneous Work Included

- a. The piping system scope of work shall include the following, unless otherwise specified:
 - a1. Miscellaneous Piping, Appurtenances and Accessories:
 - a1.1 Provide all necessary miscellaneous piping, vents, drains and piping accessories and appurtenances (except where specifically indicated to the contrary), fittings, pipe supporting elements, bypasses for piping and specialties, insulation supports, pipe saddles for insulation protection, unions, couplings, pipe flanges, gaskets, bolting, nozzles, sample piping.
 - a1.2 Provide such other miscellaneous piping, vents and drains, pump gland and packing connections and appurtenances, which may not be shown on the design drawings but which may be required to complete the work and to make the piping system and equipment function properly.
 - a2. All traps, float cages and similar appurtenances shall be installed with suitable unions or flanged couplings to permit their removal for maintenance purposes, unless otherwise specified.

201.4 Materials

- All items shall be marked with manufacturer's name or trademark and ASTM or ASME material designation.
- a. A product analysis shall be provided.
- b. Pipe shall have a shop hydrostatic test per ASTM A530. Fittings shall also be hydrostatically tested similar to pipe.
- c. A certified test report per ASTM A530 shall be provided to the DISTRICT.
- d. Ferritic steel pipe with schedule wall thickness shall conform to the dimensions and tolerances of ANSI B36.10.
- e. Stainless steel pipe with schedule wall thickness shall conform to the dimensions and tolerances of ANSI B36.19.
- f. Filament Wound Fiberglass Reinforced Plastic (FRP) pipe to include 100 mil liner. Joints to be bell and spigot for structural adhesive bonding, plain end for butt and wrap welding, and/or socket flanges for structural adhesive bonding. (NOTE ARE THERE ANY SPECIFIC "CODES AND STDS" FOR FRP ?
- g. All austenitic stainless steel materials shall be in a solution-annealed condition, which shall consist of heating to 1900°F or higher and holding for an appropriate time. Subsequent cooling shall be from the annealing temperature to below 800°F to prevent carbide precipitation in the grain boundaries. Austenitic stainless steel shall not be used if subjected to a post-weld heat treatment in the range of 800°F to 1800°F, regardless of subsequent cooling rate.

PART 3 – EXECUTION

301. FABRICATION AND INSTALLATION

301.1 Shop Fabrication

- a. Fabrication of piping shall be performed in an off-site permanently established shop with all facilities for pipe fabrication, welding, certification, testing, cleaning and painting. The fabrication shop or SUBCONTRACTOR shall be experienced in piping fabrication.
- b. Piping shall be fabricated by CONTRACTOR to the maximum extent possible as constrained by shipping size limits.



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- c. All piping shall be fabricated and welded in the shop as far as possible to reduce the number of field joints to a minimum.
- d. Piping fabrication and testing procedures shall be made available for DISTRICT's reference and/or review.
- e. Field welds shall be located so that they are readily accessible for welding and (when required) for stress relieving.
- f. The length of shop-welded sections shall be determined by shipping limitations, maneuverability and erection space available, subject to review and acceptance by the DISTRICT.
- g. CONTRACTOR shall meet "C" dimensions on all ends to be field welded.
- h. The ends of all weld connections on shop-fabricated sections shall be properly machined in accordance with the welded joint specified.
- i. All flange attachments shall be rechecked after welding to ensure proper alignment.
- j. Each shop-fabricated section of piping shall have all nozzles, weld end fittings and all couplings and nipples for drains or for instrument connections welded on in the shop, as far as possible.
- k. Thermowells shall be installed with the axis of the thermowells at right angles to the pipeline or duct wall for all ducts and for all pipelines larger than 4 inches. For pipelines 4 inches and smaller, pipe portion to be expanded with a tee and thermowells shall be installed the tee section.

301.2 General Fabrication

- a. CONTRACTOR shall comply with the recommendations and procedures of the ASME code and the Pipe Fabrication Institute (PFI) publications. Where conflicting requirements exist between the two the governing ASME code shall govern.
- b. Change of direction in welded pipelines shall be made by means of welding fittings.
- c. Branch Connections:
 - c1. CONTRACTOR shall be responsible for the proper design and fabrication of all piping system branch connections that are furnished as part of the WORK. The rules governing the design of branch connections shall be in accordance with the applicable requirements of the governing code. All additional reinforcement required by the design conditions shall be provided by CONTRACTOR / Seller in the fabrication of the branch connections.
 - c2. Welded branch connections shall be carefully fitted and properly reinforced as required by the governing code.
- d. Nozzles on headers to which stop valves, safety valves and relief valves are welded shall have inside and outside diameters that correspond to the inside and outside diameters of the welding ends of the valves to which they connect.
- e. The safety and relief valves as well as discharge piping shall be designed by the CONTRACTOR according to the reaction force produced by discharge flow at maximum accumulation and the forces produced until the maximum back pressure has been built or the steady flow has been reached. The connection pipe from the valve inlet nozzle to the header shall be straight and as short as possible. The reinforcement of the pipe section shall be in compliance with the applicable codes. Using pads at connections between the main path and the inlet nozzle shall be avoided.
- f. In all steel piping systems employing butt-weld joints and fittings for sizes 2½ in. and larger and socket-weld or screwed joints and fittings for sizes 2 in. and smaller, transition from lines in sizes 2½ in. and larger to lines in sizes 2 in. and smaller shall be made as follows:



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- f1. For transitions down from sizes larger than 6 in., a flued head transition piece shall be used when sizes are available; otherwise, the pipe shall be terminated with a butt-weld cap and a socket-weld or threaded coupling or half-coupling shall be welded to the pipe upstream of the cap for attachment of the 2 in. and smaller pipe.
- f2. For transitions down from sizes 2½ in. through 6 in., a welding reducer with butt-weld preparation shall be used. The reducer shall conform to the applicable requirements of ANSI B16.9.
- f3. Threaded connections shall not be used.
- g. All steel butt-welding fittings shall be as fully strong as the pipe to which they are connected and shall be in accordance with the ANSI B16.9. Short-radius fittings shall not be used.
- h. Companion flange unions shall be provided at any necessary equipment connections and at all transitions between welded and screwed piping.
- 302. SPECIFIC FABRICATION REQUIREMENTS
- 302.1 Attachments Welded to Piping
 - a. Provide all lugs, clips, plates, rings, eyes, clamps, saddles, etc. welded to piping fabricated by CONTRACTOR.
 - a1. Attachments required on vertical pipe runs required for support of insulation.
 - a2. Saddles required to protect insulation at hangers, supports, etc.
 - a3. Shear lugs for pipe.
 - a4. Other attachments required for connecting of pipe supports.
 - a5. Temporary attachments for handling alignment, etc.
 - b. Attachment material shall have the same nominal chemical composition as the piping to which it is connected. Ferritic steel attachments shall not be welded directly to stainless steel piping. Carbon steel attachments shall not be welded directly to alloy steel piping.
 - c. Weld metal shall be similar to and compatible with that of the piping and attachment.
 - d. Attachment welds shall be in accordance with the applicable requirements of the governing code, with procedures and welders qualified in accordance with ASME Section IX and acceptable to the DISTRICT.
 - e. Removal of Temporary Attachments: Unless otherwise specified, the following shall apply:
 - e1. All temporary attachments shall, after serving their purpose, be removed by mechanical or thermal cutting as close to the pipe surface as is practical without gouging into the pipe surface. The remaining portion shall be ground smooth to meet the contour of the pipe.
 - e2. All areas where lugs or attachments are removed or repaired shall be examined by magnetic particle or liquid penetrant methods and meet acceptance standards as stated in ASME B31.1. Any linear indications shall be removed and the area retested. Procedure shall be repeated until no indications are noted.
 - f. Shear Lugs:
 - f1. Shear lugs shall be fabricated of plate or bar stock having the same nominal chemical composition as, and equal or better minimum specified mechanical properties than, the material of the pipe to which they are attached.
 - f2. Shear lugs on non-critical piping systems may be attached with either full penetration or partial penetration welds as specified.



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- f3. For shear lugs installed on vertical runs of piping for piping support, shop or field welds (other than a seam of welded pipe) are not permitted within 1½ feet of the bottom of the shear lugs, in order to permit proper fitup of the support clamps.
- g. Saddles and clamps
 - g1. Saddles shall be provided for any bottom-supported (trapeze) horizontal lines having an insulation thickness over 1 inch. Rod attachments at clamps shall be clear of the insulation.
 - g2. Riser Clamps: Surfaces bearing against pipe attachments shall be ground so that all parts of pipe attachments will be bearing against clamp surfaces.
 - g3. Pipe saddles shall be made to fit the curvature of the pipe. If roller bearings are used, pipe shall be guided.
 - g4. Insulated piping shall be provided with standard piping covering protection saddles except where special details are indicated or required.
- h. Anchors Guides and Restraints

All anchors, guides, braces, etc., shall be fabricated in a neat and workmanlike manner. Bearing surfaces and bolt holes shall not be flame cut. If flame cutting is to be used on surfaces to be welded, scale and oxide shall be ground away before welding. All screw or similar adjusting devices shall be provided with positive locking features.
- i. Full Penetration Attachment
 - i1. The full penetration weld shall have the root of the joint back gouged to sound metal before the opposite side is welded. The gouged area shall be given a magnetic particle examination to confirm that sound metal has been obtained.
 - i2. The full penetration weld shall be completed with concave fillets (¼-inch minimum) on all sides to provide the proper weld contour. Fillet weld profile shall be in accordance with equal leg, concave fillet shown in ASME B31.1. All weld passes shall be wrapped around the top and bottom of the lugs as well as the sides. Convex fillet welds may be deposited provided that the final fillet weld contour is ground or machined concave. The bottom face of the lug and attachment weld shall be found flat.
 - i3. After the shear lugs and pipe have cooled from the final stress relief or post-weld heat treatment, the lug welds shall be examined 100% volumetrically by ultrasonic methods for defects in the weld-and heat-affected zone. The lug welds and adjacent base material (at least ½ inch on each side of the weld) shall also be examined for surface defects by either the magnetic particle or liquid penetrant method.
 - i4. A "Double J-Groove" type full penetration attachment weld can be used in lieu of the double bevel type weld.
- j. Partial Penetration Attachment:
 - j1. The partial penetration weld shall be a continuous weld on the sides and top of the lugs. The weld shall be completed with concave fillets (¼-inch minimum) on all sides to provide the proper weld contour. Fillet weld profile shall be in accordance with equal leg, concave fillet shown in ASME B31.1. Convex fillet welds may be deposited provided that the final fillet weld contour is ground or machined concave.
 - j2. The root pass and each ¼-inch layer of deposited weld metal shall be examined by either the magnetic particle or liquid penetrant method while the lug is being attached.
 - j3. After the shear lugs and pipe have cooled from the final stress relief, the lug welds and the base material for at least ½ inch on each side of the weld shall be examined for surface defects by either the magnetic particle or liquid penetrant method.



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302.2 Testing

a. Ultrasonic Testing Acceptance Standards:

a1. All indications which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such reflectors and evaluate them in terms of the acceptance standards as follows:

a2. Discontinuities are unacceptable if the amplitude exceeds the reference level or if the discontinuities have lengths which exceed:

a2.1 $\frac{1}{4}$ inch for t up to $\frac{3}{4}$ inch, inclusive;

a2.2 $\frac{1}{3}$ t for t from $\frac{3}{4}$ inch to $2\frac{1}{4}$ inches, inclusive;

a2.3 $\frac{3}{4}$ inch for t over $2\frac{1}{4}$ inches;

where "t" is the thickness of the weld being examined. If a weld joins two members having different thicknesses at the weld, t is the thinner of these two thicknesses.

a3. Where discontinuities are interpreted to be cracks, lack of fusion or incomplete penetration, they are unacceptable regardless of discontinuity or signal amplitude.

a4. Ultrasonic test reports for shear lugs shall show the size and location of all reportable indications.

b. Magnetic Particle/Liquid Penetrant Evaluation of Indications:

b1. Mechanical discontinuities at the surface will be indicated by retention of the examination medium; however, localized surface imperfections, such as may occur from machining marks or surface conditions, may produce similar indications which are non-relevant to the detection of unacceptable discontinuities.

b2. Any indication that is believed to be non-relevant shall be regarded as a defect and shall be reexamined to verify whether or not actual defects are present. Surface conditioning may precede the reexamination. Non-relevant indications, which would mask indications of defects, are unacceptable.

b3. Relevant indications are those which result from mechanical discontinuities. Linear indications are those indications in which the length is more than three times the width. Rounded indications are indications that are circular or elliptical with the length less than three times the width.

c. Magnetic Particle/Liquid Penetrant Acceptance Standards:

c1. Indications with major dimensions greater than $\frac{1}{16}$ inch shall be considered relevant.

c2. The following relevant indications are unacceptable:

c2.1 Any cracks or linear indications;

c2.2 Rounded indications with dimensions greater than $\frac{3}{16}$ inch;

c2.3 Four or more rounded indications in a line separated by $\frac{1}{16}$ inch or less edge-to-edge;

c2.4 Ten or more rounded indications in any 6 square inches of surface with the major dimensions of this area not to exceed 6 inches and the area taken in the most unfavorable location relative to the indications being evaluated.

d. The bottom surfaces of the shear lugs shall be within plus or minus $\frac{1}{8}$ inch of the true elevations shown on the design drawings. In addition, the bottom surfaces of the shear lugs at any one nominal elevations shall be within a tolerance of plus or minus $\frac{1}{32}$ inch with respect to each other.



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303. WELDING

303.1 General

- a. Welding procedures, welders and welding operators shall be qualified in accordance with applicable code requirements. Records of the names of the welders who make each weld shall be maintained.
- b. Documentation relative to the welder, welding operator and procedure qualification shall be made available at a location where the Work is being performed and shall be available for audit.
- c. Site facilities shall be provided where all welders shall perform qualification tests. CONTRACTOR shall provide for on-site weld qualifications.
- d. CONTRACTOR shall conform to all requirements of AWS. Any other special requirements shall be written in the CONTRACTOR's proposal.
- e. Base material shall be prepared in accordance with the following requirements.
- f. The edges or surfaces of the parts to be joined by welding shall be machined or thermal cut and cleaned of all oil, grease, scale, rust or other deleterious materials. Where thermal cutting is used, all loose scale must be removed. All remaining kerf residue (fused during the cutting process) and sharp cut surface cavities must be removed or blended by grinding or chipping to assure proper weld penetration.
- g. Welding shall be performed by one or more of the following processes. Other processes will be permitted when the technical efficiency has been demonstrated to the satisfaction of DISTRICT. The following are considered suitable welding methods:
 - g1. Shielded metal arc welding (SMAW)
 - g2. Submerged arc welding (SAW)
 - g3. Gas tungsten arc welding (GTAW)
 - g4. Gas metal arc welding (GMAW)
 - g5. Limitations regarding the above welding methods are as follows:
 - g5.1 Low hydrogen electrodes must be used for shielded metal arc welding.
 - g5.2 Filler metal addition must be used with the gas tungsten arc process.
- h. Short circuit arc welding may not be used to join materials greater than ¼ inches in thickness. The process can be used to deposit the root pass and additional weld passes in the root region of butt joints up to a deposited weld metal thickness of ¼ inches.
- i. Cored wire designed for operation without use of externally supplied shielding (i.e., air wire) is not allowed. Such wire shall also not be used with arc shielding gas.
- j. Filler metal and flux storage and handling
 - j1. Welding materials shall conform to the requirements of ASME or AWC filler material specifications. Filler metal to be used for joining shall be analytically compatible with the base material. Primary consideration shall be given to mechanical properties, corrosion resistance and welding reaction as applicable for the particular job requirements.
 - j2. All welding filler material shall be stored both in the shop and at site in clean, dry areas and protected from contamination or mechanical damage. All low hydrogen covered electrodes shall be purchased in hermetically sealed containers. Electrodes shall be dried prior to use, in accordance with the manufacturers recommendations, if the hermetically sealed container shows any evidence of damage, the wet electrodes can not be used, all electrodes which are not immediately used shall be stored in ovens at 200°F minimum.



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- j3. After opening of hermetically sealed containers or removal of electrodes from drying ovens, permissible atmospheric exposure time shall be four hours for both carbon and stainless steel low hydrogen covered electrodes.
- j4. Electrodes, which are not used within the permissible exposure time limits, shall be put back to ovens. Electrodes, which are exposed to the atmosphere for longer time than the above limits, shall be dried again in accordance with manufacturer's recommendations.
- k. Welding shall be done based on CONTRACTOR written procedures, which shall comply with all applicable procedures. Following precautions shall be included:
 - k1. All slag or flux or foreign material remaining on any bead of welding shall be removed before depositing the next successive bead.
 - k2. Grinding or brushing of stainless materials shall be done with wheels or stainless steel wire brushes not previously used on carbon or low alloy steels.
 - k3. Any cracks or blow holes that appear on the surface of any bead of welding shall be removed by chipping or grinding before depositing the next successive bead of welding, according to acceptable industry standards.
 - k4. No different metal welding shall be done at site. Weld joints shall be preheated before any welding is performed in accordance with the requirements of ANSI/ASME B31.1. Heating techniques and temperature measurements procedures shall be such as to ensure that the weld joint preparation and adjacent base material are at the specified temperatures. Intermediate layer preheat shall be provided as required.
 - k5. Welds shall be postweld heat treated in accordance with the applicable code requirements including required holding temperature, time cycle and heating and cooling rates. CONTRACTOR shall provide heat treatment curves.
 - k6. Where members being joined are of unequal thickness, the section thickness at the location of the heavily heat affected zone shall be the governing thickness for determining the holding duration and the heating and cooling rates.
 - k7. All marking fluid, chalk, tape and other material deleterious to material during thermal treatments shall be removed prior to postweld heat treatment.
 - k8. Welder qualification shall be in accordance with ASME Section IX requirements.
 - k9. All weld repairs shall be made using the same preheating and post heat treatment as that on the original weld.
- l. All socket welds shall have a minimum of two weld passes.
- m. Each weld pass shall be visually inspected for defects and slag. All defects and slag found shall be removed by chipping and grinding prior to the deposit of additional filler metal.
- n. Peening of weld metal is not permitted.
- o. Stainless steel weldments shall be cleaned with stainless steel wire brushes and iron-free abrasive discs not previously used on ferritic materials.
- p. All solvents used for stainless steel shall be non-halogenated and non-sulfur bearing.
- q. The use of low carbon (e.g., E-9018B3L) electrodes/weld filler metal is not permitted on chrome-moly materials.
- r. Tack Welding
- rl. Tack welds shall be made by procedures and welders qualified in accordance with ASME Section IX.



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- r2. All filler metals used for tack welds shall be of the same composition as the filler metal for the joint.
- r3. Tack welds that are incorporated into the finished weld shall be visually inspected for defects. All defects shall be removed before covering tack welds with additional weld metal.
- s. Weld Metal
 - The composition of filler metals shall be of a chemical composition similar to the base material.
- t. Stainless Steel Filler Metal
 - Each heat and each lot of austenitic stainless steel filler metal shall be purchased to have a delta ferrite number of 5FN minimum. This does not apply to filler metal used for cladding.
- u. Weld Contour
 - u1. The contour of the weld reinforcement on the inside and outside of each weld shall conform to the requirements of the governing code and (for welded pipe and fittings) to the material specification. For girth welds the contour shall be maintained as close as possible to the outline shown on the welding end detail drawings.
 - u2. Welds shall have a gradual increase in thickness from the edges to the center and the surface transition shall be smooth without ridges or depressions, on the inside and outside of weld, unless otherwise specified.
 - u3. Where radiography is required, the inside and outside of finished surface of the weld in ferritic steel systems shall be ground smooth and flat within 1/32 in. of the base material, unless the fabricator can demonstrate to the satisfaction of the DISTRICT that the as-welded surface will not produce radiographic film indications that could mask a defect. The above shall also apply to welds in stainless steel systems, except that the inside surfaces (where accessible) shall be machined; no grinding of internal surfaces of stainless steel systems is permitted.
 - u4. Where radiography is not required, grinding of welds shall be as follows:
 - u4.1 For Girth Weld Joint in Piping:
 - u4.1.1 For other piping systems, at pipe-to-pipe joints and pipe-to-casting joints, grinding is not required where the weld reinforcement is smooth and follows the contour shown on the weld end detail.
 - u5. All evidence of arc strikes or weld deposits adjacent to the weld preparation on the base metal shall be removed by grinding and if necessary, weld repaired; this also includes arc areas caused by magnetic particle inspection prods and weld areas remaining after the removal of temporary attachments. Arc strikes shall be repaired before stress relieving.
- v. Heat Treatment:
 - v1. Preheat and post-heat treatment of welded joints shall be in accordance with the requirements of the applicable codes.
 - v2. Electric or gas heat sources shall be used for preheat. Temperature monitoring with temperature-indicating crayons is acceptable for preheat.
 - v3. Electric heating sources, automatic or manual temperature control and automatic chart recorders shall be used in post-heat treatment of welds. Heating and cooling rates during post-heat treatment shall be controlled in accordance with the governing code. For stress relieving in the shop, a gas-fired furnace may be used.

- v4. Recorder charts of post-heat treatment, weld records showing welding procedure number (including preheat), welder and radiograph reference (if performed), etc. shall be kept on file by the CONTRACTOR and shall be available to the DISTRICT for reference. After completion of the WORK, these records shall become the property of the DISTRICT.
- v5. Electrical heat sources shall be used for field stress relieving of piping.
- v6. Austenitic stainless steel components shall have a maximum interpass temperature of 350°F.
- w. Nondestructive Examination (NDE) and Testing:
 - w1. All pipe and fitting materials shall receive all testing and examination required by ASME B31.1, ASME Section I or the applicable ASTM or ASME material specifications.
 - w2. Nondestructive examinations shall be in accordance with the examination procedures of ASME Section V and as herein specified. The examination shall be performed by personnel who have been qualified in accordance with SNT-TC-1A, Supplements and Appendices, as applicable, for the technique and methods used.
 - w3. All nondestructive examinations performed shall be executed in accordance with the detailed written procedures and shall comply with the appropriate article of ASME Section V.
 - w4. Radiographic examination of welds shall be in accordance with ASME Section V, Article 2 and with the acceptance standards set forth in ASME B31.1 and ASME Section I, PW-51, whichever governs.
 - w5. Magnetic Particle, liquid penetrant and visual testing required by ASME B31.1 shall be conducted and evaluated in accordance with ASME B31.1.
 - x. Internal misalignment at the weld ends shall in no case exceed the limit specified in ASME B31.1. For critical piping systems, the internal misalignment shall not exceed 1/16 in. at any point.
 - y. The minimum wall thickness specified by the DISTRICT for pipe, fittings, etc., shall be maintained at weld joints, as well as at other areas.
 - z. Special Access Openings and Plugs for Radiographic Examination of Welds:
 - z1. CONTRACTOR shall provide all access openings in piping required for radiographs and shall furnish all plugs required for access holes. The CONTRACTOR shall provide any/all rings or other reinforcing required for the access holes.
 - z1.1 Access openings shall not be provided where radiographic geometrical unsharpness, limitations cannot be met. In general, piping up to Schedule 120, between 6 and 24 inches NPS may be radiographed satisfactorily by utilizing access holes.
 - z1.2 Geometrical unsharpness limitations shall be as set forth in ASME Section V, Article 2, Paragraph T-285.
 - z1.3 Access openings shall not be provided in piping less than 6 inches NPS.
 - z2. Plugs and reinforcing shall be of the same material as the pipe in which they are installed; access holes, plugs and reinforcing shall conform to requirements of the governing code(s) and shall be in accordance with PFI ES-16. For applications on pipelines having design temperatures of 900°F and above the seal weld shall have a minimum 3/8-inch fillet weld.
 - z3. After radiographs are complete, the CONTRACTOR shall install plugs in all access holes for shop radiographs and piping erector shall install plugs in all access holes for field radiographs.
 - aa. All qualified welders shall be provided with an identification stamp of the low stress type. The welder shall stamp each of his welds with his identification. The stamp shall be located on the base material adjacent to the weld. An acceptable alternate to stamping is to have the welder's identification traceable to the joint by documentation.



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- bb. If for any reason it becomes necessary, in the opinion of the DISTRICT, to test the quality of welds that have been made by CONTRACTOR in either shop-fabricated or field-fabricated assemblies, standard test specimens shall be removed from the designated welds by CONTRACTOR and tested in the presence of the DISTRICT.
- 303.2 Non-Ferrous Joints: Joints in fiberglass reinforced plastic piping shall be as required by the application. All joints shall be made by certified joiners. Individual joiners shall be trained and certified by the manufacturer for the specific pipe brand, type of joint and pipe sizes to be used.
- 303.3 Instrumentation
 - a. CONTRACTOR shall furnish and install all the bosses for the pressure taps, thermowells and testwells specified or required.
- 304. INSPECTION AND TESTING
- 304.1 CONTRACTOR shall prepare and submit an Inspection and Test Plan for review and acceptance by the DISTRICT. The plan shall address all examination and testing and submittal of documentation required by the governing code(s).
- 304.2 The quality control procedures shall include as a minimum welding, nondestructive testing, heat treating, packaging and shipping, shop testing procedures, cleaning and painting.
- 304.3 All pipe and fittings furnished, fabricated and installed by CONTRACTOR shall be certified to conform to the hydrostatic test requirements, if any, in the applicable ANSI/ASME Codes and ASTM Standards. Shop hydrostatic testing of piping assemblies is not required when the foregoing has been met.
- 304.4 If hydrostatic testing is performed, test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Water used for hydrostatic testing of stainless steel piping shall be potable and not have a chloride content exceeding 100 ppm. The minimum temperature of the water used for hydrostatic testing shall be 70°F.
- 304.5 Mill certifications required by applicable code and standards shall be submitted to the DISTRICT for review.
- 304.6 All pipe and fitting materials for main piping system shall receive all testing and NDE required by ANSI B31.1, ASME Section I and the application ASTM or ASME material specification.
- 304.7 All NDE performed shall be executed in accordance with detailed written procedures and shall comply with the appropriate article of ASME Section V and as herein specified. The examination shall be performed by personnel who have been qualified in accordance with SNT-TC-1A, Supplements and Appendices, as applicable, for the technique and methods used and specified herein.
- 304.8 All radiographic examinations of welds shall be in accordance with ASME Section V, Article 2 and performed with the acceptance standards set forth in ANSI B31.1 and ASME Section I, PW-51, as applicable.
- 304.9 All magnetic particle, liquid penetrant and visual testing required by ANSI B31.1 shall be conducted and evaluated in accordance with ANSI/ASME B31.1.
- 305. CLEANING
- 305.1 After fabrication of the piping and prior to shipment to the site, the internal surface of piping shall be cleaned to remove 100% of mill scale.
- 305.2 All piping that has been internally cleaned will have the internal surface coated with a water-soluble rust inhibitor such as Dubois 200 or equal.



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- 305.3 Flange facings and other machined surfaces for ferrous metal materials, except butt-weld end preparations, will be coated with a suitable antirust compound.
- 305.4 Field welds on all piping materials will be painted with a Deoxy Aluminate or equivalent coating.
- 305.5 The external surface of all ferrous metal piping will be commercial blast cleaned in accordance with SSPC SP-6 and receive one (1) coat of inorganic zinc primer.
- 306. FLUSHING
CONTRACTOR shall prepare the piping systems for flushing. Flush water shall be provided by others.
- 307. SHIPPING
307.1 The inside of all piping spools shall be verified to be clean of all foreign matter prior to shipment.
307.2 Piping spools shall be protected for shipment per the requirements of PFI ES-31.
307.3 Materials shall be provided with protection against damage, corrosion and internal contamination in accordance with the following:
307.4 All materials and equipment shall be packaged, packed or prepared for shipment in a manner which will ensure arrival at destination in satisfactory condition. Procedure and details shall be submitted to the DISTRICT for review prior to start of shipment.
307.5 All openings in piping and equipment furnished by CONTRACTOR shall be securely plugged, capped or otherwise blanked off, sealed with tape and suitably protected against damage and entry of foreign materials and moisture. For shop-fabricated piping, this shall be done as soon as possible after shop cleaning.
307.6 Weld ends on all valves, fittings, pipes, nozzles, etc. shall be capped and sealed with suitable, firmly attached protectors. Butt-weld ends on ferrous materials shall be coated with Special Chemicals Corporation Deoxaluminite, or acceptable equal, prior to capping, back to a ring whose length is the same as the weld preparation plus 2 in. minimum.
307.7 All flange facings, bolt holes and other machined surfaces of ferrous materials (except butt joint end preparation) shall be coated with a suitable removable antirust compound. No coatings shall be applied to nonferrous materials.
307.8 All flanged connections and loose flanges shall be provided with suitable full face flange protectors bolted in place and sealed.
307.9 All protectors for openings and all braces, brackets, spacers, ties, bindings and other shipping, packaging and packing materials and appurtenances used for protection in shipping, storing and handling of nonferrous piping and materials shall be of such design, type and/or arrangement as to prohibit contact between ferrous and nonferrous materials.
- 308. IDENTIFICATION OF PIPELINE AND COMPONENTS
308.1 All piping components furnished by CONTRACTOR shall have a securely attached metal tag marked to identify each item and its particular service. Tags shall be furnished in accordance with Section 016131 – Nameplates and Tags.
308.2 For pipe, tubing, fittings and shop fabricated piping sections the tags shall be temporarily attached.
308.3 All steel pipe shipped in random lengths shall be color-coded with identifying color stripes indicating pipe material (ASTM or ASME number and grade) and schedule running the full length of each pipe to prevent interchanging pipe types during installation. In addition, each length and each piece cut from a length shall be marked with the applicable ASTM or ASME number, grade and heat number.



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Stamping of pipe will be permitted only if blunt-nosed continuous or blunt-nosed interrupted-dot die stamps are used.

TABLE 2.1
ALLOWABLE NOZZLE LOADS

Nozzle Nom OD (in)	Act. OD (in)	Schedule	Maximum Allowable Moment (ft-lb)	Maximum Allowable Force (lb)
1/8	0.405	40	8	1
	0.405	80	9	1
1/4	0.540	40	19	2
	0.540	80	22	2
3/8	0.675	40	34	3
	0.675	80	40	4
1/2	0.840	40	64	6
	0.840	80	75	7
	0.840	160	82	8
	0.840	XXS	90	8
3/4	1.050	40	110	10
	1.050	80	130	12
	1.050	160	160	14
	1.050	XXS	170	16
1	1.315	40	210	18
	1.315	80	250	22
	1.315	160	300	26
	1.315	XXS	330	30
1 1/4	1.660	40	370	30
	1.660	80	460	40
	1.660	160	530	50
	1.660	XXS	640	60
1 1/2	1.900	40	510	40
	1.900	80	640	50
	1.990	160	790	70
	1.990	XXS	930	80
2	2.375	40	880	70
	2.375	80	1,140	90
	2.375	160	1,530	120
	2.375	XXS	1,730	140
2 1/2	2.875	40	1,660	130
	2.875	80	2,090	160
	2.875	160	2,560	200
	2.875	XXS	3,120	240
3	3.500	40	2,690	200
	3.500	80	3,480	260
	3.500	160	4,500	330
	3.500	XXS	5,350	400
4	4.500	STD-40	5,000	300
	4.500	XS-80	6,700	500
	4.500	120	8,100	600



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Nozzle Nom OD (in)	Act. OD (in)	Schedule	Maximum Allowable Moment (ft-lb)	Maximum Allowable Force (lb)
	4.500	160	9,200	600
	4.500	XXS	10,600	700
6	6.625	STD-40	13,300	800
	6.625	XS-80	19,100	1,100
	6.625	120	23,400	1,400
	6.625	160	27,800	1,700
	6.625	XXS	31,300	1,900
8	8.625	20	20,900	1,100
	8.625	30	23,000	1,200
	8.625	STD-40	26,300	1,400
	8.625	60	32,200	1,700
	8.625	XS-80	38,300	2,100
	8.625	100	44,000	2,400
	8.625	120	51,000	2,700
	8.625	140	55,700	3,000
	8.625	XXS	58,700	3,200
	8.625	160	60,100	3,200
10	10.750	20	33,100	1,600
	10.750	30	39,900	1,900
	10.750	STD-40	46,700	2,300
	10.750	60	61,600	3,000
	10.750	80	71,300	3,400
	10.750	100	83,300	4,000
	10.750	120	94,300	4,500
	10.750	XXS140	107,000	5,200
	10.750	160	116,000	5,600
12	12.750	20	47,000	2,100
	12.750	30	61,000	2,700
	12.750	STD	68,000	3,000
	12.750	40	74,000	3,200
	12.750	XS	89,000	3,900
	12.750	60	98,000	4,300
	12.750	80	117,000	5,100
	12.750	100	138,000	6,100
	12.750	XXS-120	157,000	6,900
	12.750	140	172,000	7,500
	12.750	160	191,000	8,400
14	14.000	20	70,00	2,900
	14.000	STD-30	83,000	3,500
	14.000	40	96,000	4,000
	14.000	XS	108,000	4,500
	14.000	60	126,000	5,200
	14.000	80	153,000	6,400
	14.000	100	184,000	7,700
	14.000	120	208,000	8,700
	14.000	140	229,000	9,600



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Nozzle Nom OD (in)	Act. OD (in)	Schedule	Maximum Allowable Moment (ft-lb)	Maximum Allowable Force (lb)
	14.000	160	249,000	10,400
16	16.000	20	92,000	3,600
	16.000	STD-30	110,000	4,200
	16.000	XS-40	143,000	5,500
	16.000	60	182,000	7,000
	16.000	80	226,000	8,700
	16.000	100	266,000	10,200
	16.000	120	304,000	11,700
	16.000	140	344,000	13,200
	16.000	160	370,000	14,200
18	18.000	20	118,000	4,200
	18.000	STD	140,000	5,000
	18.000	30	162,000	5,800
	18.000	XS	183,000	6,500
	18.000	40	203,000	7,300
	18.000	60	263,000	9,400
	18.000	80	319,000	11,400
	18.000	100	378,000	13,500
	18.000	120	434,000	15,500
	18.000	140	477,000	17,000
	18.000	160	524,000	18,700
20	20.000	STD-20	174,000	5,800
	20.000	XS-30	228,000	7,600
	20.000	40	267,000	8,900
	20.000	60	353,000	11,800
	20.000	80	433,000	14,400
	20.000	100	518,000	17,300
	20.000	120	587,000	19,600
	20.000	140	659,000	22,000
	20.000	160	717,000	23,900
22	22.000	STD-20	212,000	6,600
	22.000	XS-30	277,000	8,700
	22.000	60	461,000	14,400
	22.000	80	573,000	17,900
	22.000	100	676,000	21,100
	22.000	120	772,000	24,100
	22.000	140	860,000	26,900
	22.000	160	941,000	29,400
24	24.000	STD-20	253,000	7,400
	24.000	XS	332,000	9,800
	24.000	30	370,000	10,900
	24.000	40	446,000	13,100
	24.000	60	606,000	17,800
	24.000	80	739,000	21,700
	24.000	100	892,000	26,200
	24.000	120	1,019,000	30,000



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Nozzle Nom OD (in)	Act. OD (in)	Schedule	Maximum Allowable Moment (ft-lb)	Maximum Allowable Force (lb)
	24.000	140	1,123,000	33,000
	24.000	160	1,232,000	36,200
30	30.000	STD	399,000	10,000
	30.000	XS-20	525,000	13,100
	30.000	30	648,000	16,200
	30.000	0.75"	768,000	19,200
	30.000	0.875"	885,000	22,100
	30.000	1.00"	999,000	25,000
	30.000	1.375"	1,322,000	33,100
	30.000	1.50"	1,424,000	35,600

END OF SECTION 400513